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SOCIETY OF MOTION PICTURE ENGINEERS

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OCTOBER, 1917

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SOCIETY OF MOTION PICTURE ENGINEERS

Membership in the Society of Motion Picture Engineers stands for unselfish service to the Industry. Applications for membership are by invitation and endorsement. All checks should be made payable to the Society of Motion Picture Engineers.

All receipts are expended directly to promote the objects of the Society and the interests of its members. There are no salaries or emoluments of any kind.

The following are extracts from the By-Laws:

The objects of the Society are: The advancement in the theory and practice of motion picture engineering and the allied arts and sciences, the standardization of the mechanisms and practices employed therein, and the maintenance of a high professional standing among its members.

An Active Member is one who is actually engaged in designing, developing or manufacturing materials, mechanisms or processes used in this or allied arts; and an Associate Member is one who, though not eligible to membership in the active class, is interested directly in the art.

Any person of good character may be a member in any or all classes to which he is eligible.

Prospective members shall be proposed in writing by at least two members in good standing, and may be elected only by the unanimous vote of the Board of Governors.

All aplications for membership or transfers in class shall be made on blank forms provided for the purpose, and shall be accompanied by the required fee.

The entrance fee for all members shall be twenty-five dollars ($25.00). The annual dues shall be ten dollars ($10.00), payable in advance before the annual meeting (October) of each year. That is, the total fee for the first year, which includes the entrance fees and first annual dues, is $35.00 for all members.

PRESIDENT'S ADDRESS

October 8, 1917.

GENTLEMEN:

This is our anniversary gathering. The Society of Motion Picture Engineers is just a year old. From a haudful who met in Washington a year ago in July to prepare for its consummation in October, this Society has grown by the addition of other men earnestly and unselfishly laboring for the good of the industry. This growth has been an accelerating one as the honestly skeptical became more and more convinced of our integrity of purpose and solidity and permanency of organization.

May I also remind you of a fact of which I am likewise proud, i. e., that our meetings have been harmonious, doubtless because only gentlemen have been in attendance. All discussions have been constructive. No criticism has been made at any session which was not at once followed by constructive suggestions. No one impuned a wholly selfish motive in the remarks of any speaker. The apparent purpose of each member in attendance has been to take action of value to the industry as a whole. This is well, for along that line only is progress, and growth, strength and respect for our Society.

We have accomplished much already and will do a great deal more. But if we had done nothing further than establish a standard frame line it would have been worth all the time and effort and expense attendant thereupon.

Let me illustrate: Some time since the Federal Government sent two camera men into our great National Parks to take motion pictures of the beauties and wonders therein, the giant geysers, lofty waterfalls, mirror lakes, and the like. I was asked to a private showing of these pictures, and found the photography of both men so good that the work of each was spliced into that of the other without a discordant tone, but the ensemble as a whole was horrible, for one camera framed on perforations and the other between. The projecting machine man, at first, tried to frame as fast as these misframes occurred, but soon gave it up as impossible and the audience was the loser. A beautiful picture ruined, and much time and money wasted, all because two cameras with different frame lines were used on the same work. Let us hope the pictures made of this great war by Government photographers may not be like that. Perhaps they will respect our recommendations and adopt a standard frame line in all their cameras.

As a Society we can only recommend; we are not either a legislative, executive, or judicial body. Nor is our Society trying to compel anybody to do anything. For example, it is not trying to legislate a given film speed, or to require every mechanism to be run at this speed. It has no such power and no such desire.

Recommendations of the Society as to a standard in any given case simply reflect the concensus of opinion of the engineers of our industry. Anyone may run his apparatus faster or slower than this standard, but because it is a standard the inquirer has something to use as a basis for intelligent discussion of the subject. He is able to say that a camera running at 66 feet a minute is running 10% above the standard, and which some may prefer in an exciting war scene, or 54 feet per minute, i. e., 10% below standard, which may work out better for a slap-stick comedy scene.

It is the same with regard to the size of the aperture, as another example. One projector manufacturer chooses a ¾" height, another prefers ⅝" perhaps, and there is nothing to prevent either from making the aperture what he pleases. But the recommendation of this Society is that, for uniformity, all apertures be .678" high, and as this is therefore likely to be adopted by many the way is smoother for all if each conforms to this standard. That is all there is to it.

I think if we keep this point of view clearly in mind our work will be better understood and more appreciated by all, for we are only making recommendations looking toward very desirable uniformity in the industry, with its resultant advantages.

Similar standardization is what has made the automobile industry, and yet I remember when there were fourteen different tire valve nipples, and stopping at a "horseless carriage" repair shop did not always mean one could get air in one's tire; the shop might have but thirteen of the fourteen, and mine was the other one.

I really don't think our industry was ever as bad as that, perhaps, but the floating frame line has been a nightmare to many a projection machine operator.

Just a further word, an apology, and I stop, for we have much that is important to do at this meeting. If the work of the past year has seemed to be dominated by your president it was only because it seemed necessary in order to get much needed work done. Or if this has given offense to any fellow member, it certainly was unintentional and I shall have sincere regrets when I learn of it. There is precedent for it, of course, for every successful organization must have a final judicial head, who must take the deciding action, even though backed by an advisory body of no mean attainments. I have had hearty cooperation and valuable assistance from many of you and take this opportunity to pub'icly thank each of you. I trust that you will continue similar support of your next president, whoever he may be, and that the standards we have set may be universally accepted, to the good of the whole industry.

Ultimately I want to see the Society of Motion Picture Engineers an international association, with world objects for world good.

C. Francis Jenkins.

MOTION PICTURE STANDARDS

ADOPTED IN COMMITTEE OF
THE WHOLE SOCIETY

The following standards, in addition to those previously adopted as standards by the Society of Motion Picture Engineers, are promulgated to encourage uniformity and standard practice throughout the Industry as a whole. The early universal adoption of all of them will save the Industry a great deal of present annoyance and monetary loss.

Projection lens opening—The diameter of unit opening for projecting lens holder shall be 1 15-16 inch.

Projection objectives—Shall have the equivalent focal length marked thereon in inches and quarters and halves of an inch, in decimals, with a plus (+) or minus (—) tolerence not to exceed 1 per cent of the designated equivalent focal length also marked by the proper sign following the figure.

Reel—The approved standard reel shall be 11 inches in diameter; 1½ inches inside width; with 5-16-inch center hole, with a key-way ⅛" by ⅛" extending all the way through; a 5-inch hub; and a permissible flange wabble of not more than 1-16-inch.

Standard reel of film—Shall have black film leaders, with tinted (red, green or blue) trailers; should have marking thereon embossed rather than punched in the film; and each reel of a multiple reel story should end with a title, and the next reel begin with the same title.

Take-up pull—The take-up pull on film shall not exceed 15 ounces at the periphery of a 10-inch reel or 16-ounces on a standard (11-inch) reel.

MOTION PICTURE NOMENCLATURE

ADOPTED IN COMMITTEE OF
THE WHOLE SOCIETY

change-over—The stopping of one projecting machine and the simultaneous starting of a second machine in order to maintain an uninterrupted picture on the screen when showing a multiple-reel story.

dissolve—The gradual transition of one scene into another.

double exposure—The exposure of a negative film in a camera twice before development.

double printing—The exposure of the sensitive film under two negatives prior to development.

fade-in—The graduation formation of the picture from darkness to full screen brilliancy.

fade-out—The gradual disappearance of the screen-picture into blackness. (The reverse of fade-in).

footage—Film length measured in feet.

panoram (verb), **panorama** (noun)—The act of, or device for, turning a motion picture camera horizontally, to photograph a moving object, or to embrace a wide angle of view.

single picture crank—(sometimes referred to as trick spindle)—The spindle and crank on a motion picture camera which makes one exposure at each complete revolution.

tilt—The act of, or device for, moving a camera vertically while in use.

vision—A new subject introduced into the main picture, by the gradual fading-in and fading-out of the new subject, as, for example, to visualize a thought.

OFFSET PROJECTION

WILL G. SMITH

When a projecting machine is set in any other position than directly opposite the center of the picture screen, in other words, when the projecting machine is "offset" from the center of the screen, certain highly undesirable effects are produced in the picture. These undesirable effects are of two kinds, first, blurring of certain edges of the picture and, second, distortion of the objects appearing on the screen.

Taking up the first of these effects, blurring of the edges, this is seen to be due to the fact that one edge of the screen is further from the lens than the other edge, and, consequently, if any chosen part of the picture is "focused" clearly on the screen other parts of the picture must, of necessity, be "out of focus." When the "offset" of the projecting machine from the screen center is not greater than, say, 5° to 10° then the blurring effect is not particularly noticeable, but when, as in some theatres in present use, the angle is as great as 35° it is utterly impossible to produce a clear picture of any attractive size.

The second of the ill effects of "offset" projection, the distortion of the objects shown, is due to the fact that the light beam coming from the projection machine to the screen is cone shaped and grows rapidly larger in area as the screen is approached. Consequently, if a section is taken through such a light cone at an angle, then, since one edge of the section plane cuts a narrower part of the beam than the other edge, it follows that one edge of the picture will be larger than the other; and further, since the further the cutting section is taken from the lens the larger the projection is, it follows that the same object moving to different positions in the picture will undergo a change in size.

Considering now a special case, which is perhaps the most common case of "offset projection," let us consider that the projecting machine is placed in the balcony of a theatre directly in line with the center of the screen on the stage but considerably above it. Then the light cone will come down to the screen and strike at an angle and the following undesirable effects will be apparent:

1. The top and bottom of the picture will be blurred while the middle will be clear.
2. A body moving from the top to the bottom of the picture will become considerably larger.
3. All vertical objects will be large at the bottom and small at the top—for instance, a man will have big feet and a small head.
4. All objects will be abnormally tall.

When the projecting machine is horizontally in line with the center of the screen but a considerable distance to one side or the other of it, then the same distortions are present in the picture, but with some difference, as follows:

1. The sides of the picture will be blurred while the middle will be clear.
2. A body moving from one side to the other of the picture will become larger or smaller.
3. All horizontal objects will be larger at one end than at the other.
4. All objects will be abnormally long.

In some theatres the projecting machine is offset both horizontally and vertically, in which case the picture shows evidence of both kinds of distortion described in the special case above.

There have been certain attempts made to correct the bad effects of "offset projection" but, owing to the fact that offset projection is basically wrong, these methods have proved far from successful. These corrective methods consist in:

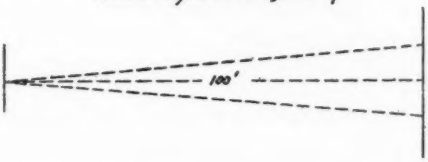
1. Filing the aperture plate of the projecting machine, and thus giving the light cone a distorted shape previous to its reaching the screen—the result of this distortion and the natural distortion being neutral and thus having a picture with a correct border line. **But, it should be noted that this method does not in any way correct the distortion actually within the border.**
2. Showing a small picture high upon the screen. The disadvantage of this method is apparent.
3. Tipping the screen one way or the other. This method makes the picture hard on the eyes of the audience and is, consequently, little used.

In conclusion it may be stated that there is at the present time only one way of preventing the ill effects of "offset projection" and that is to eliminate the "offset," in other words, to place the projecting machine nearly opposite the center of the screen.

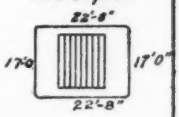
DWG. No. 200-1

OFFSET PROJECTION
EFFECT ON PICTURE

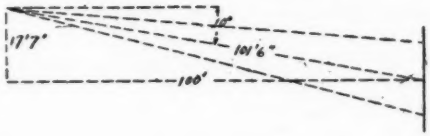
Picture Projected Horizontally

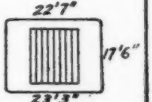


Picture Shape Rectangular

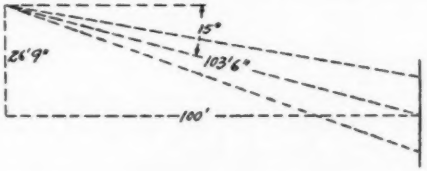


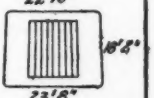
Picture Projected 10° Down from Horizontal





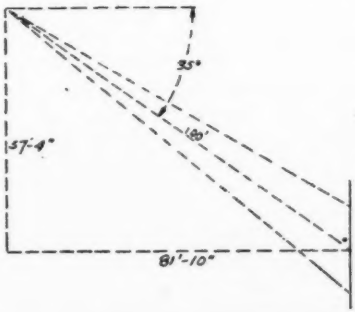
Picture Projected 15° Down from Horizontal

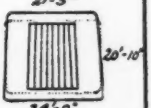


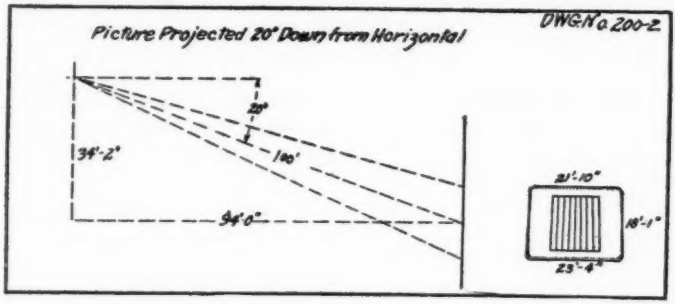


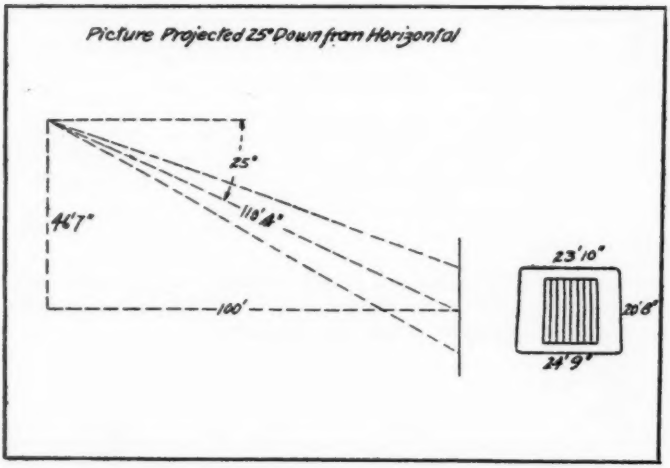
DWG. No. 200-3

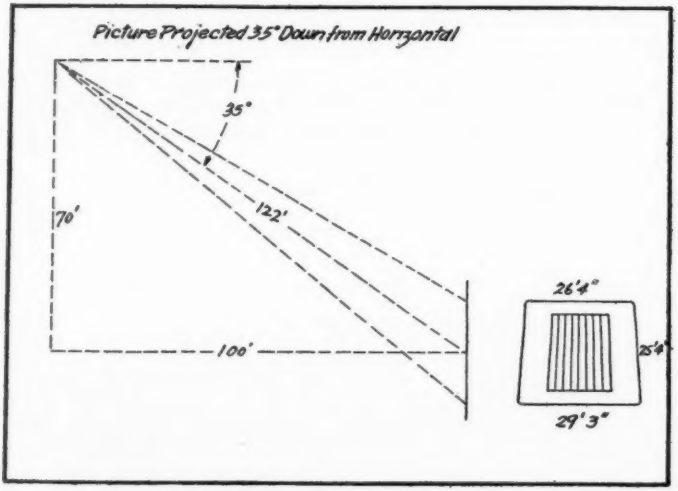
Picture Projected 35° Down from Horizontal






Picture Projected 20° Down from Horizontal
DWG. No. 200-2
20°
34'-2"
100'
94'-0"
21'-10"
18'-1"
23'-4"


Picture Projected 25° Down from Horizontal
25°
46'7"
118'4"
100'
23'10"
20'8"
24'9"


Picture Projected 35° Down from Horizontal
35°
70'
122'
100'
26'4"
25'4"
29'3"

THE MOTION PICTURE BOOTH

C. FRANCIS JENKINS

The motion picture booth was inaugurated several years ago when motion pictures began to be used in "Picture Parlors." The pictures were popular and the demand for projecting machines grew faster than the supply with the result that even the poorest kind of machine was salable.

These poor machines with half inclosed arc lamps and the tissue-like film, the only kind available, were the cause of too frequent fires.

A still further factor of hazard was the type of man who first took up the public exhibition of this new show device, a type of man who did not build solidly and for the future but for a "front" and the quick dollar.

So to confine the fire which was almost sure to ensue sooner or later from this combination of flimsy machine, tissue-like film and careless handling, the fire authorities of a large city inaugurated the booth inclosure of metal or asbestos and the regulation was more or less copied by other cities, the idea being to confine such fire as might occur.

But as years passed the machines improved and the film was strengthened, until today the film is twice as thick as it was at first, and machines are now available which totally inclose the film at all points. The machine manufacturer has, therefore, gone about as far as he can go, and it is squarely up to the authorities to make the handling of the film safe, and this can be done most successfully by making the operator work in sight all the time.

The modern machine and film is not a hazardous combination. Whatever danger there is today comes about by the operator fastening the magazine doors open, by smoking, by failure to immediately return the film to its metal container when taken from the machine magazine after its showing, and such like disregard of ordinary caution. This is recognized by municipal authorities and regulations to this effect are almost universal.

But laws will no more stop such practices than laws will prevent theft; and we all unconsciously confess, daily, that, better than law, the way to protect one's personal property is to watch it.

For the same physiological reason the projection room should be wire-glass-walled on two, or three, sides. And also because it would please the skilled, conscientious operator who is proud of his work and workroom, and it is only fair that this justifiable pride should be rewarded by easier public observation.

The concealing booth is an anomaly, anyhow. In no other human employment involving public hazard is the operator concealed from observation. In driving taxicabs, we put tags on the driver and the machine, "so we can get his number;" instinctively we avoid dark

streets, so as not to invite danger from the slinking thug; and even when we put a night watchman to watching a building we put a clock to watching the watchman.

But when it comes to motion pictures, we reverse this natural custom and at least hang around the operator a shower-bath curtain so that nobody can watch him. It would be strange if it did not involve danger, for a booth isn't a factor of safety; on the contrary, it is a hazard, because it invites negligence, or worse.

When this established principle is recognized by our authorities and booths required which do not conceal the operator, the motion picture projector manufacturer will be released from blame for film fires, and we will quickly arrive at a time when "booth fires" will be a thing of the past.

It seems much more sensible to prevent fires than to employ means to confine them when such means only invite a conflagration. Picture film of itself is not unsafe. It does not evaporate and give off inflammable vapors like gasoline nor will it ignite spontaneously, as is proved by the thousands of rolls of picture film on the shelves of photo supply stores all over the world. Tons and tons of it are made daily in Rochester alone, but they have never had a film fire, for all operatives work in the open.

Picture theatre booths should be constructed with the front wall opaque so that the audience may not see or be disturbed by what is happening in the booth, as now arranged, but the booth should have the sides and rear wall of wire-glass, or some such plan as will give an unobstructed view of the inside of the booth at all times, by the owner, by inspectors, and others. (Just why booths are not provided with that excellent fire enemy, the sprinkler system, with inch heads, is inexplicable to me.)

In temporary installations, certainly, the safest plan is to do away with the concealing booth entirely. It is much wiser to require the handling of the film in the open, and where the operator has ample room to work safely, than in the confined space of a shower-bath curtain booth. It may be contended that the curtain is to prevent panic, but one has but to remember that no temporary booth could confine the smoke of burning film, and smoke has caused more panic than fire ever has. Whereas, on the other hand, if there were no booths there would be no fires, where a safe machine is employed.

The concealing booth is a source of unnecessary hazard and the cause of more fires than ever have been prevented thereby, and should, therefore, be done away with.

Daily the picture film is coming more and more to be recognized for what it is, the greatest of all teachers. It speaks the only universal language. No other device equals it for conveying a message, and probably never will.

The invention of the printing press, in the 15th century, gave a tremendous impetus to learning, but it appealed only to a class, for it was limited to those who could read. The invention of the motion picture of the 20th century began a second and greater era of learning for it speaks to the masses as well; to the old and young, to the illiterate as well as the learned of every tongue, and it should not be forgotten

that the illiterate of our earth constitute a body many times greater than those who can read. Again, the printing press must print for each man in his own tongue, while the motion picture prints in a language all can read. The printing press is autocratic, the motion picture democratic.

The immeasurable opportunity for good in the new picture press is rather rapidly coming to be recognized, I am happy to say, but it would go forward with greater stride if the handicap of the unnecessary, hazardous concealing booth, for the class-room, lecture hall, or outdoor gathering, could be removed without delay. Ultimately this requirement will become obsolete and a dead letter just as the prohibition to automobiles aboard ferry boats, but teaching would be the great gainer if this could come soon.

Let us remove unnecessary obstructions to the rapid and wide use in the school room of so wonderful a teacher; and also give to the motion picture in theatres a better name by the use of a glass booth.

REPORT OF COMMITTEE ON ELECTRICAL DEVICES

H. M. WIBLE, Chairman
W. C. KUNZMANN
H. A. CAMPE
MAX MAYER
J. C. MOULTON
ROBT. P. BURROWS

The Committee on Electrical Devices has made an investigation of the various forms of converting equipment for use in operating D. C. arcs from A. C. mains and submits for your approval the following report, which intends to show the characteristics and advantages of each of the forms. Information has not yet been secured on all of the devices on the market and this report, therefore, does not include the entire list.

The ultimate purpose of such an investigation is to determine the principles by which the selection of apparatus for any installation may be made. Briefly summarized, the data submitted by the several manufacturers result in the general principles stated below.

Owing to the lack of data, it has been necessary to limit the recommendations for application to Mercury Arc Rectifiers and Motor Generator Sets, but it is probable that the same considerations applying to the Motor Generator Sets will apply to Rotary Converters in a general way.

Either type of equipment will give satisfactory service when properly installed and cared for as directed. The question as to which piece of apparatus should be adopted should properly be determined by the local conditions of the individual application.

The arc current required is determined by:

(a) Dimensions of screen
(b) Length of throw
(c) Reflective value of screen
(d) Intensity of general illumination
(e) Angle of projection
(f) Type of density of film.

Information to be taken into consideration in selecting one equipment where either may be applied is listed below:

(a) There is a difference in over-all efficiency between the Motor Generator Set and rectifier.
(b) The first cost, including installation, is lower for the rectifier.

(c) The rectifier may be and usually is installed in the operator's booth.

(d) In cases where it seems necessary that both arcs be operated simultaneously for any purpose, the Motor Generator is the proper equipment. Some theatres operate two machines from a single rectifier by stealing the arc from one machine to the other, without any warming-up period.

Mercury Arc Rectifier Equipment

The equipments now made for this service differ only in details and the descriptions of the outfits are, therefore, combined for sake of brevity, and mercury arc rectifiers have been recognized as standards for a number of years.

The equipments now made consist of a transformer, regulating reactance, a bulb or tube, control mechanism, and an automatic starting device. The transformer and regulating reactance, which may be included as part of the transformer, are for the purpose of reducing the line voltage to the proper value and provide stability to the arc. The bulb or tube serves as an electrical valve, which prevents the flow of current in the wrong direction. The connections are such as to utilize current from two different parts of the transformer winding in such a manner as to secure continuous current, and the transformer is so designed that the pulsations are slight.

These connections, which are internal to the rectifier, are shown in the two diagrams, Figures No. 1 and 2, which illustrate two types of rectifier equipments in common use. The only external connections are those required to bring the supply to the A. C. Terminals of the outfit through a switch and fuses, and to carry the load current from the D. C. terminals to the lamps.

In order to compensate for variations in line voltage and to permit adjustments to be made to take care of variable conditions, such as film density, etc., means are provided for controlling the current, by changing connections of the reactance or transformer. These outfits are so arranged as to permit the operation of an A. C. arc as an emergency measure.

For convenience in operating and to permit the installation of the outfit at some distance from the operator, automatic starting devices are provided. These are such that the outfit is started by closing the line switch and striking the arc.

The over-all efficiency of the rectifier is approximately 70%. This represents the percentage power from the line, which is delivered in the form of power to the arc.

All outfits are designed so as to operate at full load continuously without temperatures that are unsafe.

Mercury Arc Rectifiers are made in 30, 40 or 50 D. C. amperes capacity, and can be made for service on any commercial A. C. circuit. The inherent characteristics of all outfits are such as to make the arc voltage at normal current highly efficient.

MOTOR GENERATOR EQUIPMENT

Those investigated, and on which your Committee is prepared to report, consist of two general A. C. to D. C. types which may be classified under the headings of:

Constant Current
Constant Potential
also
D. C. to D. C. Types.

Constant Current Equipment—A. C. to D. C.

The A. C. to D. C. equipment is a straight motor generator set of a standard alternating current induction motor direct connected to a special D. C. generator. Both units are mounted on a common bed plate, forming a three-bearing set.

This equipment is built in three sizes—35, 50 and 70 amperes. These machines are designed to handle one arc continuously, and two arcs for a short period of time when changing over the pictures. During the process of changing over, when two arcs are burning, they are connected in series across the armature of the generator. The 35 ampere machine is designed to run one lamp at 35 amperes, 55 volts, and two lamps at 35 amperes, 110 volts. The 50 ampere machine is designed to run one lamp at 50 amperes, 60 volts, and two lamps at 50 amperes, 120 volts. The 70 ampere machine will operate one lamp, 70 amperes, 65 volts, and two lamps at 70 amperes, 130 volts.

In Figure No. 3 you will find the diagram of connections for the 35 ampere two lamp outfit.

Figure No. 4 gives a diagram of connections for the 50 to 70 ampere two lamp outfit.

These machines have an over-all efficiency of approximately 70% at their rated load. They will operate continuously under full load to a temperature rise not to exceed 40 degrees Centigrade, two hours at 25% overload, with temperature rise not to exceed 55 degrees Centigrade. They can be built for any commercial alternating current circuit, as standard induction motors are used.

The equipment includes the motor generator set complete, a steel panel, on which is mounted an ammeter and generator field rheostat. Two short-circuiting switches are also supplied, the function of which is to short circuit the arc which is not burning.

Operation

After the set is up to speed, the generator field rheostat is turned to a marked point, and one arc is short circuited. The other arc is struck in the usual manner. The voltage of the machine will automatically drop to that required by the arc depending on the current used. When ready to change over, the carbons of the second lamp are brought together until they touch, the short-circuiting switch is opened, and the carbons gradually separated. The voltage of the machine will automatically increase to take care of the added resistance, holding the current constant. To shut down the first arc, close the short-circuiting switch.

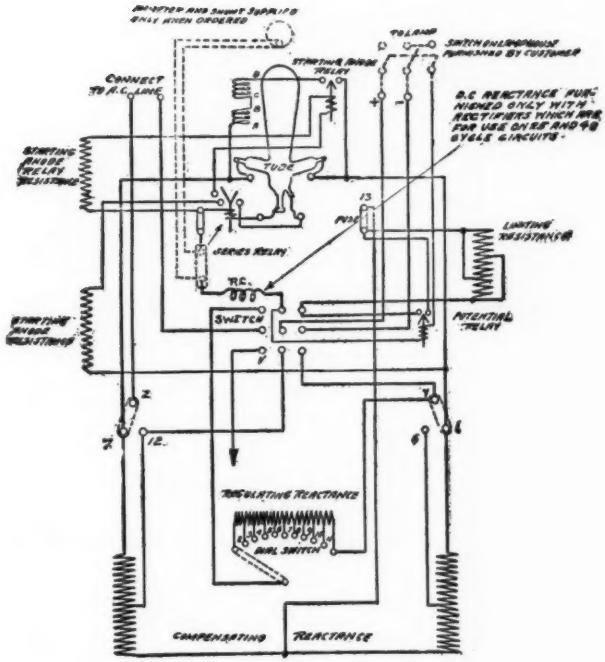

TO LINE
STARTING SWITCH RELAY
TUBE
SERIES RELAY
SWITCH
REGULATING REACTANCE
COMPENSATING REACTANCE

FIG. 1

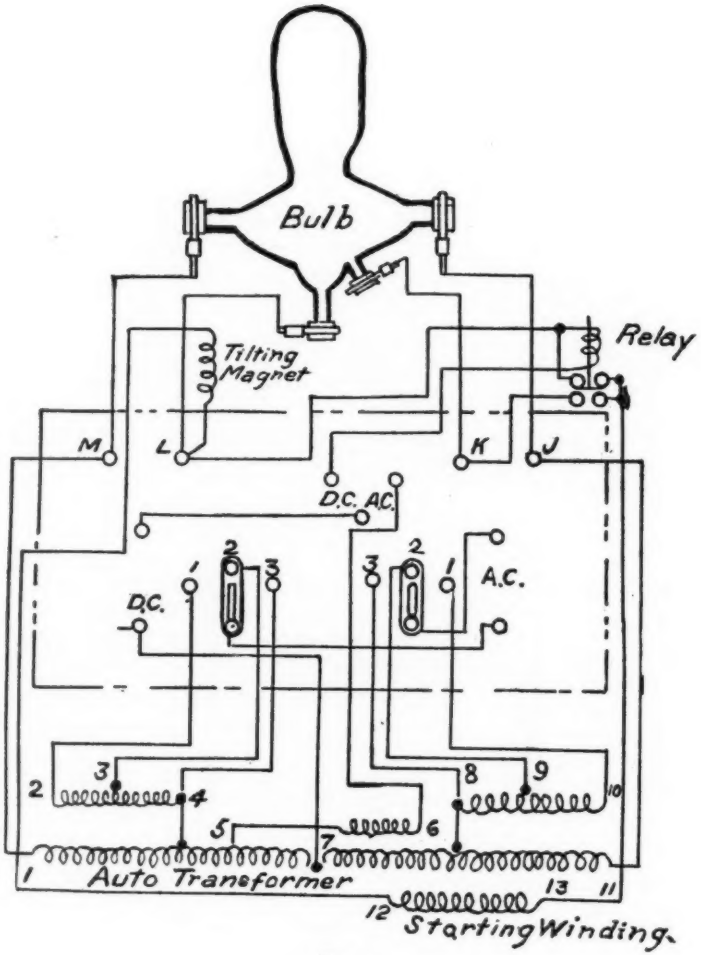

Bulb
Relay
Tilting Magnet
M
L
K
J
D.C. A.C.
D.C.
A.C.
1
2
3
2
3
4
5
6
7
8
9
10
11
12
13
Auto Transformer
Starting Winding

FIG. 2

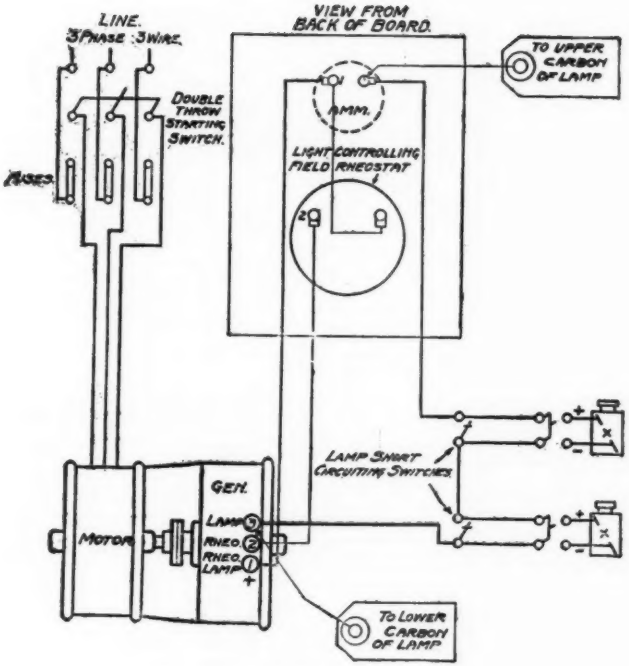

LINE.
3 PHASE 3 WIRE.
VIEW FROM BACK OF BOARD.
TO UPPER CARBON OF LAMP
DOUBLE THROW STARTING SWITCH.
AMM.
LIGHT CONTROLLING FIELD RHEOSTAT
FUSES.
LAMP SHUNT CIRCUITING SWITCHES
GEN.
MOTOR
LAMP
RHEO.
RHEO. LAMP
TO LOWER CARBON OF LAMP

FIG. 3

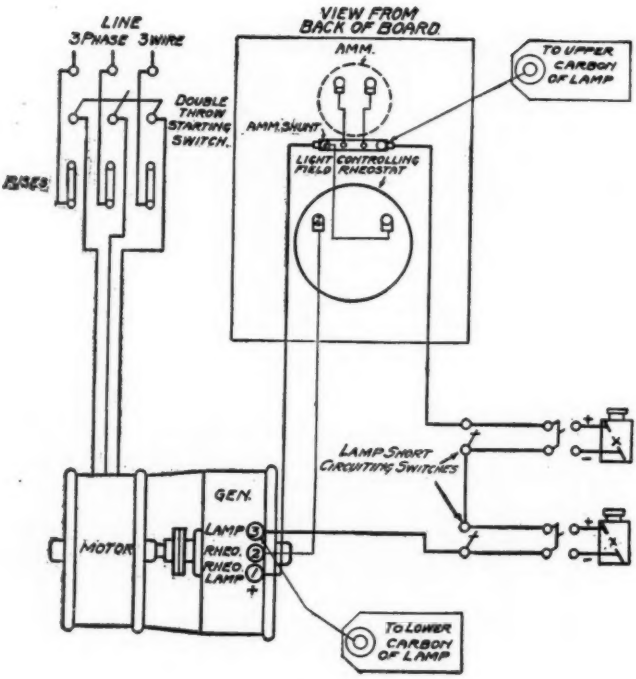

LINE
3 PHASE 3 WIRE
VIEW FROM
BACK OF BOARD
AMM.
TO UPPER
CARBON
OF LAMP
DOUBLE
THROW
STARTING
SWITCH.
AMM. SHUNT
FUSES
LIGHT
FIELD
CONTROLLING
RHEOSTAT
LAMP SHORT
CIRCUITING SWITCHES
GEN.
MOTOR
LAMP
RHEO.
RHEO.
LAMP
+
To LOWER
CARBON
OF LAMP

FIG. 4

The D. C. to D. C. equipment is not a true motor generator set, but very closely resembles a balancer set. Both armatures are mounted on a common shaft, making a two-bearing outfit, the two armatures being connected in series across the line. The arc circuit is taken from a connection between the armatures and side of the line. This volt ampere characteristic is such that one lamp can be operated from this machine without the use of a steadying resistance. The machine, therefore, not only lowers the line potential to that suitable for the projection arc, but allows the arc to be operated in a highly efficient manner.

The D. C. to D. C. outfits are built for 35, 50 and 70 ampere one-lamp equipments, and 35 and 50 ampere two-lamp equipments. The two-lamp equipments are designed with a compound field which is cut in service when two lamps are operating. The two lamps are connected in multiple across the armature of the machine; the machine very closely resembling a constant potential generator.

With the two-lamp equipments there is furnished a special panel which contains an ammeter, voltmeter, generator field rheostat and a change-over switch. The function of this change-over switch is to cut in the series field on the generator, changing its characteristic so as to allow the operation of two lamps. It is, however, necessary to use a slight amount of steadying resistance with this type of outfit when operating two lamps. This is because the outfit is practically a constant potential generator. Due to the use of the steadying resistance, the over-all efficiency is lowered about 18% when operating two lamps, 70% one lamp.

Operation

The method of operating the D. C. to D. C. outfit is as follows:

After the set is up to speed with the change-over switch on the panel closed, the first arc is struck in the usual manner. When one arc is burning, there is no steadying resistance to be used. When ready to change over, to include the second arc, the short-circuiting switch is opened, which automatically cuts in the series field of the generator and at the same time inserts a steadying resistance in series with the arc. The second arc is then struck. When ready to shut down the first arc, the arc switch is opened and the change-over on the panel closed.

The single arc D. C. to D. C. outfit consists of a motor generator complete with motor starter and generator field rheostat.

Constant Potential Equipment.

The motor generator sets built for this service each comprise a 75-volt compound wound commutating pole direct current generator, directly connected to and driven by a suitable motor, both units being mounted on a common cast iron bed plate or sub base. They are built in four capacities, namely, 40, 55, 70 and 90 amperes. Sets, the motors of which are for single phase service or for direct current service, are of the four bearing rigidly coupled type, whereas all others are of the common shaft type. The motors of all three phase sets, except the 40 ampere rating, have six leads so that the motor may be star connected

Motion Picture Equipment
SINGLE LIGHT
Schematic Connections
Panel provided for Emergency Service

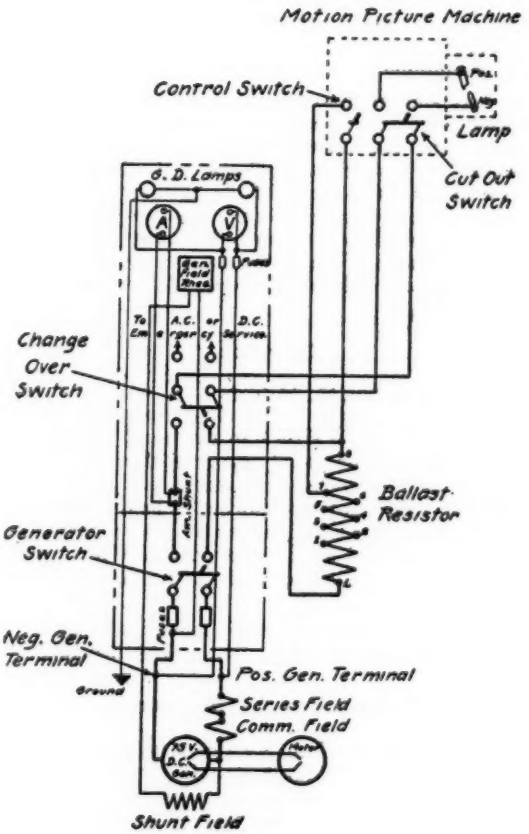
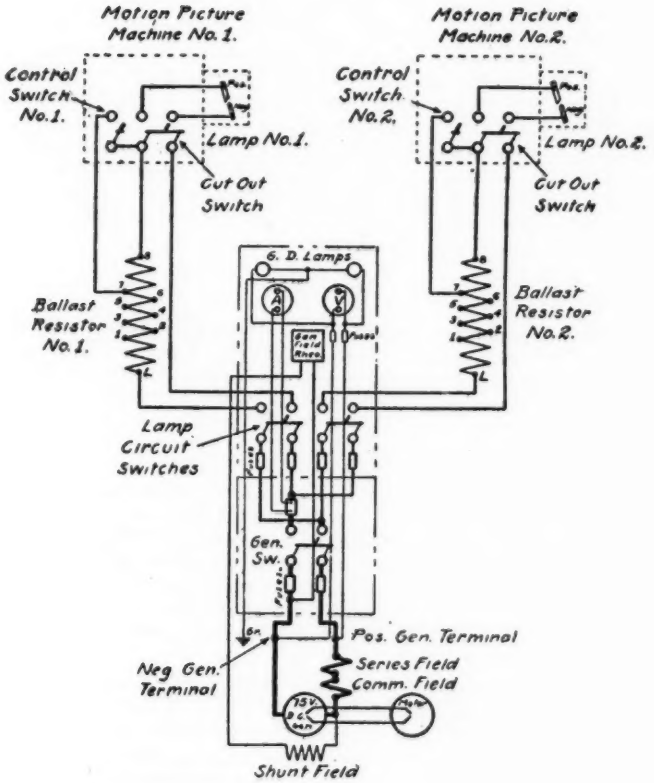


FIG. 6

Motion Picture Equipment
TWO LIGHT
Schematic Connections



Extra Heavy Lines indicate Wires which must carry Current for Both Lamps.

FIG. 7

for starting, and delta connected for running, thereby, eliminating the necessity of using a regular auto transformer for starting, with a reduced voltage at the motor terminals.

Motors for any standard commercial electric circuit can be readily supplied, as all motors used are of standard construction and characteristics.

The over-all efficiency of the various sets is approximately 70% when developing full rated capacity. The sets will operate continuously, delivering rated capacity at a temperature rise not exceeding 40 degrees Centigrade, and also are capable of delivering 125% of rated capacity for a period of two hours, at a temperature rise not exceeding 55 degrees Centigrade. Each set also will develop sufficient energy to operate two motion picture machines simultaneously during the change-over period, when one reel of picture is being finished and the subsequent reel is being started.

A complete motion picture equipment comprises a motor generator set, a ballast resistance and control switch for each motion picture machine, a control panel for the generator, and a starter, if required, for the motor. These equipments are usually connected as indicated in Figures No. 6 to No. 8, inclusive.

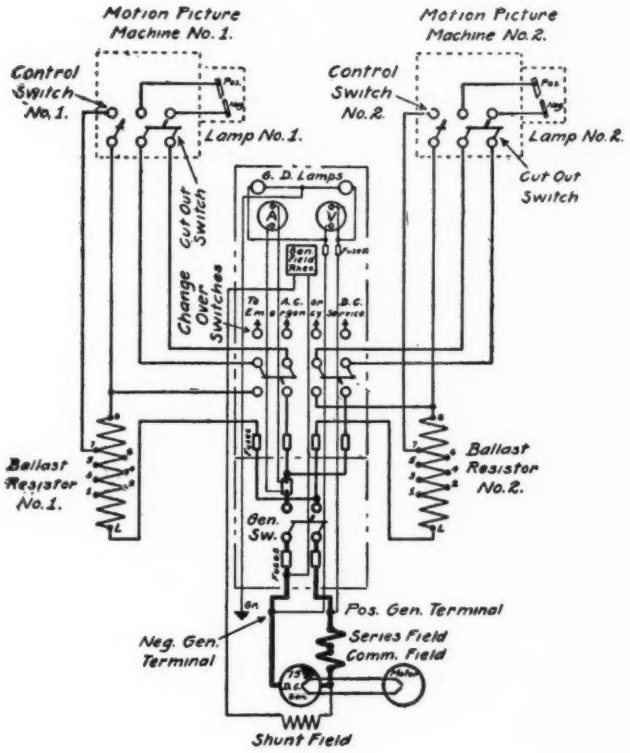
Operation

The motor generator set is started in the usual manner, after which the necessary switches are closed in the direct current circuit, so that the arc may be struck in one of the motion picture machines. The voltage developed by the generator and the voltage across a single arc is indicated by Curve, Fig. 9. The arc can be struck in the second motion picture machine when desired, but the control switch for that circuit should be opened prior to striking the arc. Opening the control switch establishes a circuit whereby all of the ballast resistance for the lamp is in series with the arc, and thereby preventing an abnormal rush of current through the lamp when the arc is struck. This also prevents any disturbance of the light produced by the other lamp. As soon as the new arc is well established, the control switch may be closed whereupon the voltage characteristics of the generator and arcs are indicated by "two arc volts," and "generator volts" indicated by Curve, Fig. 9.

Each ballast resistance is provided with a number of taps so that the current delivered to the arc may be readily adjusted for any value required within the capacity of the equipment.

The constant potential equipments, such as have been described above, have proven to be admirably well adapted for motion picture service, especially in districts where the power supply for the motor is subject to variations, resulting in changes of speed in the motor generator set. This is due to the fact that the ballast resistance in series with each arc compensates for any voltage changes of the generator, due to speed fluctuations. As a result, when the generator voltage decreases, due to a decrease of speed, the voltage drop across the ballast resistance also decreases, due to a comparatively small decrease in current, which results in higher voltage across the arc, and, therefore, the watts dissipated in the arc remain more nearly fixed, or constant.

Motion Picture Equipment
TWO LIGHT
Schematic Connections
Panel provided for Emergency Service



Extra Heavy Lines indicate Wires which must carry Current for Both Lamps.

FIG. 8

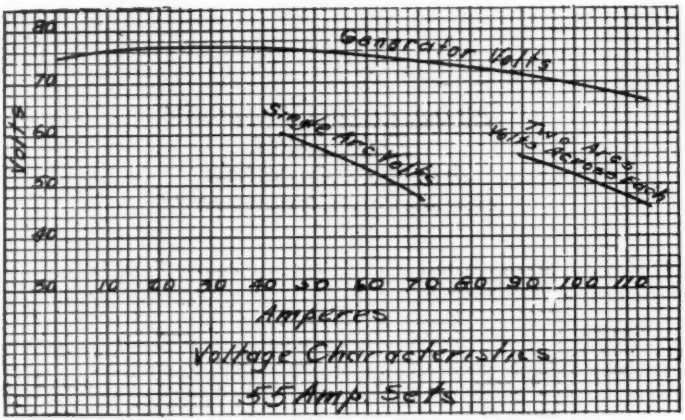


Fig. 9

As a result of these conditions, the intensity of the light generated by the arc remains more nearly constant than it will for an equipment operating under the same conditions, and feeding the arc directly from the generator without the use of a series resistance.

It is unfortunate that the Committee's efforts to secure information from all of the manufacturers met with such incomplete co-operation, and it is the Committee's suggestion that better results could be secured if a more definite effort were made to advertise the Society and its aims. The attitude of some of the manufacturers seems to be founded on the lack of faith in the motives of the Society, which can only be overcome through the united efforts of the Society.

The Committee earnestly requests that the administration of this Society take this situation under consideration and make immediate and continued efforts to overcome it, if the work of the Committee is to continue. Suggestions and criticisms are solicited from various manufacturers.

THE PROJECTION OF MOTION PICTURES BY MEANS OF INCANDESCENT LAMPS

A. R. DENINGTON

FILAMENT ARRANGEMENT:

In the development of a lamp suitable for the projection of motion pictures, it is essential that the light source be concentrated as closely as possible. After a number of experiments on filament arrangement, there have been developed two forms of filament for incandescent lamps for motion picture projection. The first successful arrangement of the filament was in two rows with coil sections parallel to each other, the coils in the second row of filament being placed so that they came between the coils in the first row. This arrangement gives the appearance of a solid source of light from a position directly in front. However, the condenser picks up light from all points within an angle of thirty to forty degrees from the line of projection. The edges of the condenser therefore pick up light from the front row of coils and those portions of the coils in the back row which are not obscured by the coils in the front row. By means of the biplane arrangement, however, it is possible to obtain a greater amount of filament within the area which can be effectively used by the condenser; the useful area with practically any condenser system being not greater than ½" square. If a spherical mirror is used back of the biplane coil, the reflected images make it possible to obtain a uniform screen.

The other system of coil arrangement consists in placing the coils in a single plane at right angles with the line of projection. This arrangement is commonly spoken of as the monoplane arrangement. With this arrangement of the filament coils, a spherical mirror is so focused that the coil images come into the spaces between coils, thus giving a fairly uniform source of light. However, with this arrangement of coils, there is an appreciable difference between the light received from the coils themselves and that received from the coil images, thus making a less uniform source of light than is obtained with the biplane construction.

CONDENSER SYSTEMS:

There are two condenser systems which are being used in the projection of motion pictures by means of gas-filled incandescent lamps. The usual plano convex condenser system which has been in use with the arc lamp was found to have some disadvantages, the principle disadvantage being the non-uniformity of illumination of the screen. With a plano convex condenser system there is a tendency for vertical bands to appear on the

screen. These vertical bands are the more or less imperfect images of the coils. By careful arrangement of the condenser and correct focusing of the lamp, these vertical bands can be made almost indiscernible on the plain screen and entirely invisible when a picture is being shown. The plano convex condenser system possesses the advantage of giving plenty of working room between the lamp house and the machine head. As the rays of light do not converge as rapidly as with the corrugated type of condenser, it is also possible where objectives of long focus are used, to get a greater proportion of the light which passes the film through the objective and on to the screen. There is also an added advantage which is of importance in the small theatre where the motion picture machine is relied upon for projecting slides, because the same condenser system can be used for projecting the slides and the film.

The screen illuminated by means of the plano convex condenser has a somewhat higher intensity at the center than at the edges. This difference, however, is not great enough to be noticeable, the average illumination in the center portion of the screen being in most cases not more than 50% higher than the illumination, measured about six inches from the edge of the screen.

The corrugated condenser which has been developed in two sizes, possesses the disadvantage of bringing the light source very close to the head of the motion picture machine, thus limiting the working space for the operator. With many machines which are in service at the present time, it is necessary to reach between the lamp house and the motion picture machine head in order to move the framing lever. It is, of course, in the interests of good projection that the film be so perfect that the framing lever need not be adjusted while the film is being run. However, the conditions which actually exist necessitate frequent adjustment of the pictures, in order to frame it correctly. The advantage of the corrugated condenser is a uniformly illuminated screen. The condenser is designed to pick up a large angle of light from the light source, but a portion of this is lost, especially at the outer edges of the condenser by surface reflection and dispersion from the molded glass. This point can be verified by holding a card in front of the machine at such a distance that the image of the condenser is formed on the card. It will be noted that the outer rings appear much darker than the central rings. There is also some loss at the apex of each ridge or ring. The light converges at a sharper angle than with the plano convex condensing system, and therefore a portion of it may be lost after passing through the film, because the objective may not be large enough to pick up the cone of light. In fact, practically all of our tests show that a higher illumination can be obtained on the screen by means of the plano convex condenser, than by means of the corrugated condenser.

OBJECTIVE LENS:

The objective lens used in the projection of pictures by means of incandescent lamps should be of wide aperture to pick up as much as possible of the cone of light which is passed through the film. In most of the projectors, the diameter of the lens holder is about 2", and the lens which is greater in diameter than 2" must therefore be held in a special adapter or mounted in a jacket on the face plate of the machine. In any event, the cone of light which passes to the lens cannot be greater in diameter than the tube or opening in which the lens is mounted. Increasing the diameter of the lens beyond about 2½", would therefore seem to be of doubtful value for existing equipment.

SCREEN RESULTS:

A number of tests of the illumination delivered to the screen, show that an incandescent lamp can be depended upon to deliver fully 600 lumens on the screen. This means that the average illumination on a screen sixteen feet in width, will be in the neighborhood of three foot candles. Our tests have shown that this illumination will produce satisfactory pictures. In fact, the pictures, when compared with those produced by a 40 ampere direct current arc, were their equal in every way, and had the added advantage of being perfectly steady.

The average illumination produced by the arc in a test case was found to be 4.8 foot candles. This average was determined by taking readings every half minute during the period of ten minutes, while the operator held the arc as steady as possible. The variation in the arc was from about 2 foot candles to 9 foot candles, the variation seemingly being caused by the wandering of the arc and by the necessity for trimming it occasionally. The measurments in both cases were taken with the shutter open. The projection distance was 112 feet.

LIGHT INTENSITIES FOR MOTION PICTURE PROJECTION

J. T. CARDWELL FOR R. P. BURROWS

I have been invited to address you on the subject, "Light Intensities for Motion Picture Projection"—a subject which is of very real importance but concerning which there is a scarcity of data. The best I can do, therefore, is to discuss the factors affecting light intensities and draw from this discussion tentative conclusions for your consideration.

First of all, it is of interest to note that the eye sees a picture on the screen not by the light which strikes the screen, but by the light which the screen reflects to the eye. If we imagine a perfectly black screen, one which reflects no light at all—we see at once that no matter how strong the beam we project on the screen we will obtain no picture at all. Screens used in practice vary in reflection factor; that is, in their power to reflect light, through very wide limits; hence it is obviously necessary to consider the reflection factor of different screens when discussing screen intensities. Nor is it correct to assume that the screen which reflects the highest percentage of light striking it is necessarily the best screen to use, for the manner in which the reflected light is distributed is also a factor which affects the brightness of the picture. For example, it is possible to conceive of a screen which reflects a very large proportion of the light striking it, yet which, due to the fact that it distributes the reflected light far out to the sides, is actually less satisfactory than one which reflects a lower percentage of the light striking it but which confines its reflected light within useful angles.

From the standpoint of their reflection characteristics, screens in common use may be divided into two classes:

Diffuse reflecting screens;
Spread reflecting screens.

Of the first class, white cloth screens and plaster screens are typical. A white cloth screen when clean can be made to reflect as high as 70 to 75% of the light which strikes it; and a plaster screen 80 to 88%. The light is reflected at wide angles, as shown in the slide. Such screens are well adapted to theatres in which the position of the seats with respect to the screen is such that the picture must be viewed at relatively large angles, for no matter from what angle the screen is viewed, the brightness is the same because of the way in which the light is reflected.

Aluminumized screens and ground-mirror screens are examples of the spread reflecting class. A clean aluminumized screen can be designed to reflect about 60 to 65 per cent of the light striking

it and will confine the reflected light within an angle of approximately 30°. Ground-mirror screens when clean can be made to reflect approximately 80 to 90% of the light and confine the light within about 30°. Such screens are well adapted to theatres in which the seats are so arranged that the picture does not have to be viewed at large angles.

Allow me to emphasize the point that the reflection factors I have mentioned assume a clean reflecting surface; a very slight accumulation of dust can reduce the screen brightness very materially. I believe that with a schedule of regular and frequent cleaning, theatre managements can in many cases increase their screen brightness by fully 50% of their present average values if they desire to do so.

Thus, it is seen that the intensity of the beam projected determines only relatively the brightness of the picture.

Uniformity of screen illumination is another factor which must be considered in connection with screen intensities. It is not uncommon to find screens upon which the intensity near the center is several times the intensity near the edges of the picture, or where the intensity on one-half of the screen is much higher than upon the other half. When this condition of non-uniformity obtains, certain portions of the picture are, of course, brighter than others and while the eye cannot readily detect small differences in brightness the fact remains that to say a screen is illuminated to a certain average intensity is not definite when a wide difference exists between minimum, average and maximum intensity values. Good projection requires a screen intensity approaching uniformity, and the nearer the intensities at different points come to being equal the better will be the projection from this standpoint. The uniformity of intensity at different points on the screen is affected by the condenser design, steadiness of the light, and by refinement in focusing adjustment.

Another factor which we must consider is extraneous light. Obviously a higher screen intensity is required in a theatre in which daylight is allowed to enter or where lights are kept burning at all times than in one where all the light comes only from the projection apparatus. The effect of extraneous light is to decrease the contrast between the high lights and the low lights on the screen. If for example the intensity of the beam in a low light of the film is, say, 1/50 of a foot candle at the screen, and in high light the intensity is, say 2 foot-candles, the contrast is 1 to 100. If upon the screen image is now superimposed an intensity of 1/10 of a foot-candle, due to extraneous light, the contrast becomes approximately 1 to 17. From this it is apparent that even a very low intensity of extraneous light calls for considerable increase in screen intensity if good contrast is to be secured. In this connection I may say that the organization with which I am connected has under way at present an investigation of motion picture theatre lighting and will be glad to co-operate

with this Society in determining what constitutes good theatre lighting and in making difinite recommendations for those interested in this subject. There is, I believe, little question that some general illumination is desirable.

Before leaving the subject of contrast, I wish to mention that film producers are endeavoring to a greater and greater extent to provide the proper degree of contrast in their films. More and more care is given to lighting their scenes in such a way that with a projecting beam of normal intensity the proper graduations of light and shade will appear on the screen.

The use of tinted and toned film is becoming more extensive. This tinting and toning serves two purposes—it lends color to the scene, and it reduces the intensity. Usually, the producer has both of these effects in mind. He uses a blue tone, let us say, to portray a moonlight scene. The color gives the observer an impression of moonlight; the producer intends in all probability that the low intensity shall help in furthering this impression. If, then, the operator, seeing that the picture is not perfectly clear, sends a rush of extra current through his carbons, he kills to an extent the impression that the producer hoped to convey. I have talked with producers who considered this natural tendency of the operator to be a matter worthy of no little consideration.

Data which I have obtained on the transmission of samples of tinted film may be of interest.

Absorption of Light by Various Tints of Films.

Film.	Per cent of Absorption.
Blank	9%
Yellow	21%
Light Amber	22%
Heavy Amber	33%
Light Blue	33%
Dark Blue	40%
Green	53%
Purple	62%
Orange	67%
Red	79%

The illumination on the screen with the shutter stationary and no film in the machine has been taken as 100%. The values for the tinted samples are given in percentage of light absorption due to the different tints. The values given in the table represent tests on a single sample of each tint and while these samples are believed to be typical others might of course show somewhat higher or lower values.

In view of the foregoing general discussion you will not be surprised when I say that suitable intensities for motion picture projection range probably from as low as 2.5 foot candles to as high as 30*, depending upon local conditions. I do not think that

*Gage, S. H. & H. P. "Optic Projection," 1914.

2.5 foot candles is sufficient for the projection of a dense film on a dusky muslin screen; neither do I think that an intensity as high as 30 foot candles is desirable for a light film projected on a highly selective or spread reflecting screen. I know of cases where theatre managements have been forced, through the complaints of their patrons, to reduce the intensities they were employing from a value near the upper limit of the range I have given to a considerably lower one. If muslin or plaster screens are used, and these are faithfully kept clean, I believe an intensity of 5 foot candles should be ample for the proper projection of all except very dense films. If an aluminumized or a ground-mirror screen is employed a value of 2½ foot candles should be ample. A great many theatres are projecting pictures with less than 3 foot candles, using a plain screen, while one of the largest and best known theatres is obtaining less than 10 foot candles on a plain screen.† The distinction between dense films and tinted and toned films is of interest. In the former, the density is due to variation in exposure and development and is not as a rule obtained with definite purpose; in the latter, the purpose is to lend color to the picture and to control its brightness. I believe that an intensity of 5 foot candles on any good, clean screen will be sufficient for the projection of any film sent out by a competent producer, and I also believe that no discomfort will be experienced from intensities in the neighborhood of 10 foot candles. In giving these values I presuppose the intensity due to the general illumination of the theatre to be of a very low order and assume the measurements to be made with the shutter open and no film in the machine. As I have previously mentioned, the effect of extraneous light in decreasing the brilliancy of a picture is very marked.

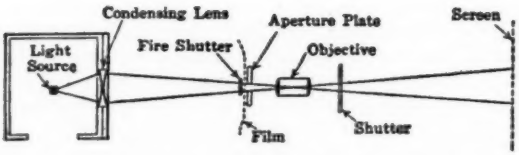
(Mr. Caldwell, by means of demonstration apparatus, showed various photographs and prints illuminated at intensities of 1, 5, and 25 foot candles. The demonstration showed that 1 foot candle was too low an intensity for good vision, that 25 foot candles was so high as to be glaring, and that color distinction and details were largely lost, and that at 5 foot candles the subject appeared to the best advantage.)

You may be interested in a device which has recently been developed which makes it possible to measure screen intensity and screen brightness very quickly and with accuracy.

In this meeting we are interested in projection apparatus only in so far as the component parts of the two systems, arc lamp and incandescent lamp, affect screen intensities. I shall discuss these two systems very briefly from this standpoint.

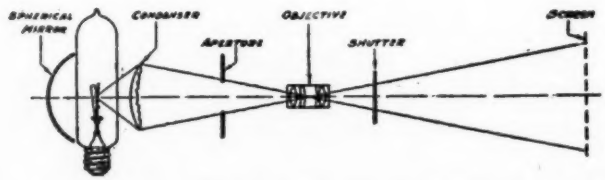
Figure 5 shows the arc lamp system as it is now and as it has been for a number of years. The light intensity at the screen with any system is of course dependent upon the light given off by the source, and with both arc lamp and incandescent lamp systems the light which the source gives off is dependent, but not in equal ratio, upon the current which flows. The intensity

†Optic Projection—J. A. Orange. See Bibliography.



on the screen can, then, be controlled within limits by the current which is forced through the source. The condensers in all arc lamp systems must be located at a considerable distance from the source, chiefly because of the intense heat of the arc, and manufacturing considerations limit the sizes of condensers to the point where, as you will note, the angle or zone subtended by the condenser with respect to the arc is small. With direct-current arcs this is not so great a handicap as with alternating-current arcs, for the direct-current arc throws the greater portion of the light it generates forward. The objectives used with arc lamp equipment are made small in diameter with respect to their focal length in order that irregularities in the arc will not be annoyingly apparent on the screen. There is a possibility of increasing the screen intensity with arc lamp apparatus by increasing the aperture of the objective lens, but under present conditions such an increase would be likely to be obtained at a sacrifice of steadiness in the picture. There seems to be a possibility of increasing the intensity produced by direct-current machines by more careful design of the shutter and possibly by rotating the shutter at higher speeds. It is doubtful if the shutters of alternating-current machines can be much improved because the cooling of the carbons is so rapid that a stroboscopic effect is likely to be encountered. This effect is, of course, marked at present where 25-cycle current must be used.

OPTICAL SYSTEM USING MAZDA C LAMP
FOR
MOTION PICTURE PROJECTION



You will note that with the incandescent lamp system, Fig. 6, a mirror can be used to redirect into useful directions the light which the lamp gives off in directions away from the condenser. The use of this mirror increases the illumination on the screen by approximately 75%. The lamp is so designed that relatively little light is thrown off to the sides, that is, a relatively large part of the light either strikes the condenser directly or indirectly

by reflection from the mirror. The fact that the light source is confined within a bulb eliminates danger of cracking the condenser; hence a short-focus condenser which subtends a large angle can be utilized. Through the design of a special prismatic condenser, Fig. 7, the necessity for a thick and heavy lens with accompanying aberration is obviated. The fact that the light source is absolutely steady and without noticeable flicker, even on 25-cycle current, permits the use of a wide aperture objective lens with an accompanying good utilization of light. Shutters can be designed to operate very effectually with incandescent lamp equipment because of the fact that the filament, being heavy, does not get a chance to cool between current reversals. When arc machines are being adapted to the incandescent lamp, it is of advantage to bear the point in mind that the shutter can usually be improved. It is due solely to the better utilization of light that the incandescent lamp, a source of lower brilliancy and far less energetic consumption than the arc, can be used to project satisfactory motion pictures.

For many years the arc lamp has been practically the only light source used in motion-picture projection work and higher and higher amperages have been employed as the size of theatres has increased and as competition between theatres has become keener. It appears that a reaction from the very high values may be logically expected, for a brilliant picture loses its attractiveness when discomfort and eye strain from glare is experienced. A bright screen viewed against a dark background produces an effect similar to that produced by a bright street light viewed against its background. In the first case the effect is less marked and may not be attributed to contrast in brightness, and for this reason is probably more serious than as if the trouble were recognized at once and corrected. Flicker and arc travel are also more pronounced at high intensities than at low ones, yet while pictures projected by incandescent lamp apparatus are free from these objectionable characteristics too high an intensity with such equipment is nevertheless quite capable of producing glare. We may, therefore, I believe, expect to see the higher intensities gradually be abandoned in favor of intensities of the lower order.

In closing, the subject of projection as treated by others should be of interest to us all. A few of the papers on this subject are:

THE PROJECTION LANTERN, by J. B. Taylor, page 414, No. 3, Vol. XI, I. E. S. Proceeding.

OPTIC PROJECTION, by J. A. Orange, page 768, No. 8, Vol. XI, I. E. S. Proceeding.

OPTIC PROJECTION, by S. P. & H. P. Gage, published by Comstock Pub. Co., Ithaca, N. Y.

PROJECTION ENGINEERING, by R. B. Chillas, Jr., page 1097, No. 9, Vol. XI, I. E. S. Proceeding.

LIGHT PROJECTION—ITS APPLICATION, by E. J. Edwards and H. H. Magdsick, a lecture delivered at the University of Pennsylvania through the I. E. S. in September, 1916, I. E. S. Proceeding.